ASSESSMENT OF INTAKES AND RADIATION DOSES FOLLOWING EXPOSURE TO TRITIATED WATER

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ABSTRACT

Biological half-lives, (Tb) of tritium following exposure to tritiated water (HTO) are reported. Tb_1 varied from 2.5 to 16 days with an average of 6.8 days. Equilibrium conditions existing between HTO concentrations in blood and urine at the time of voiding is demonstrated. Tb_1, is observed to be affected only marginally by age or body weight and significantly by ambient conditions like temperature and moisture content of the air.

INTRODUCTION

Biological half-life is an important parameter in assessment of intakes. ICRP has adopted Tb_1 of 10 days for HTO component for the purpose of internal dosimetry. Second component arising from the intake of HTO in human has been reported by a few authors, as quoted by Rudran [1988], who concludes that CEDE from the second component is about 1.5 to 2.5 times CEDE due to HTO alone. This has not been given due weightage assuming this to be less than 10% of the total (ICRP, 1979). Observations by the authors in the dose evaluation studies following intake of HTO under occupational conditions in 86 cases are reported here. Study of 40 cases of reported earlier (Thampan et. al. 1974).

METHODOLOGY

Intake of HTO in heavy water moderated cooled research reactor CIRUS (40 Mw) is negligible under normal working conditions. Following spillage of heavy water and clean up operations urine analysis of concerned persons is carried out. Follow up studies are conducted whenever the first urine samples collected exceeds concentration of 370 KBq l^{-1}. The results are evaluated for Tb_1, intake and radiation dose. Blood samples are collected from exposed individuals in the morning after overnight urine collection. Tritium as HTO in the blood sample is corrected for HTO at the mid-point of urine collection with Tb of 7 days. At times, ^3H excretion in urine is followed for longer periods. These studies lead to the observation and evaluation of a second component (Rudran 1988). Tb_1 observed in late winter during the month of Feb.-March were separated out and variations of Tb_1 with age and body weight were studied by least square analysis. From the known temperature and humidity conditions existing in Bombay at different periods of the year, moisture content of air (g/m^3) was calculated.

Variation of Tb_1 with temperature and water content in the air at the mid-point of study period was worked out.

RESULTS

Concentration of ^3H as HTO in blood and urine are given in table 1 and show that HTO is at equilibrium concentration in urine and blood at the time of voiding.

A study of 86 cases, showed Tb_1 varying from 2.5 days to 16 days. The results are presented in fig. 1. The average is 6.8 days. Thus under climatic conditions around Bombay, 7 days Tb_1 is appropriate for dosimetry.

Variation of Tb_1 w.r.t. atmospheric temperature are shown in table 2 and w.r.t. humidity conditions fig.2. The figures show an inverse relationship for Tb_1 with atmospheric water content. Tb_1 doesn't show any relationship directly attributable to ambient temperature.

26 case studies were made in late winter during Feb.-March under similar climatic conditions. These were analysed for variations due to individual parameters namely age and body weight. Results are shown in figures 3 & 4. The regression lines show that variations attributable to age or body weight are minimal.

Intake and CEDE to exposed individuals were evaluated using standard techniques (Thampan et. al. 1974, Rudran and Kirthi 1984) highest value of CEDE was 9.6 mSv when HTO component alone was taken care of. When contribution from second component is accounted for, CEDE is 25 mSv, 2.5 times that due to HTO (Rudran, 1988) and is within the annual permissible limit.

CONCLUSION

A Tb_1 of 7 days is appropriate for dose calculation from HTO intakes under tropical conditions prevalent in India. Changes in Tb_1 by a factor of 2 to 3 from the average are likely, due to ambient conditions. There is no significant change in Tb_1 due to age or body weight for the occupational group, normally 20 to 60 years and body weight group of 40 to 80 Kg.

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Table - 1

Urinary HTO and HTO in blood at the time of voiding,

Case No.	Concentration KBq/l of Tritium Urine	Blood
1.	960 ± 26	930 ± 10
2.	84 ± 2.6	84 ± 2.5
3.	340 ± 10	330 ± 10

Table - 2

Variation of Tb1 of tritiated water with ambient temperature

No. of experi-ments	Ambient Temperature °C During the Study period Maximum	Minimum	Average	Average Tb days
9	29	20	24.5	7.5
20	30	21	25.5	7.3
9	33	26.4	29.7	5.9
10	30	25	27.5	5.1
6	32	23	27.5	6.4
6	33	27	30	6.9

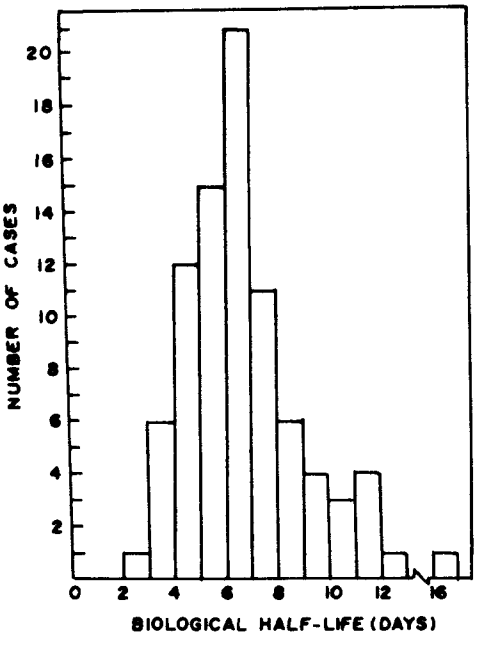

Fig. 1. Incidence of Tb_1 of Tritium (HTO)

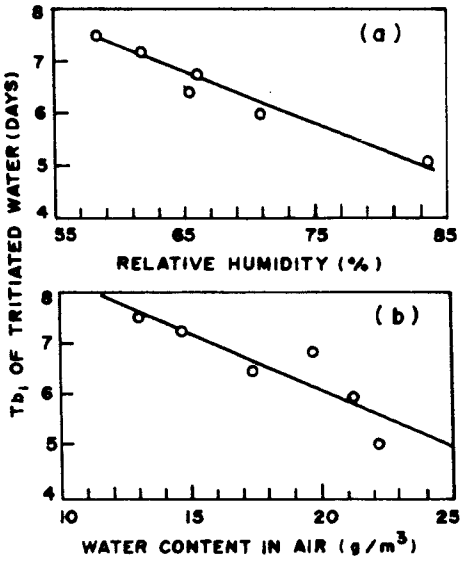

Fig. 2. Biological half-life of tritiated water Vs humidity conditions.

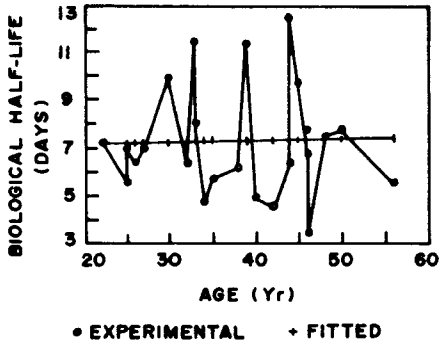

Fig. 3. Biological half-life Vs age.
(FEB - MAR)

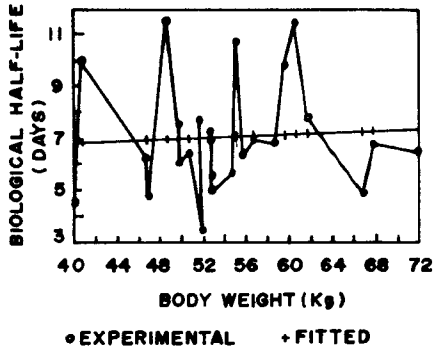

Fig. 4. Biological half-life Vs body weight.
(FEB - MAR)